

CLAIMS

- [1] A terminal device connectable to an automatic introduction apparatus for automatically introducing a target celestial object by controlling a rotation of an astronomical telescope around at least two axes, said terminal device characterized in comprising:
- an input operation section for executing a command operation on said automatic introduction apparatus; and
 - an image display section for indicating a star map image for a predetermined area on a celestial sphere in accordance with a display scale factor,
- said input operation section having:
- a rotation command means for executing a command operation on a rotational driving of said astronomical telescope in a telescope control mode; and
 - a scale factor input means for executing an input specification of said display scale factor for said star map image displayed in said image display section, wherein
- in said telescope control mode, a star map image corresponding to a position on a celestial sphere toward which said astronomical telescope is headed is displayed in said image display section, while a speed of rotation of said astronomical telescope controlled by said rotation command means is changed in accordance with a decreasing function of said display scale factor specified by said scale factor input means.
- [2] A terminal device in accordance with claim 1, in which a celestial object selecting mode is further provided,

said mode allowing either of a target celestial object for automatic introduction or a fundamental celestial object for alignment to be selected over the star map image displayed in said image display section.

5 [3] A terminal device in accordance with claim 2, in which said celestial object selecting mode further allows the star map image to be displayed in said image display section independently from said position on said celestial sphere toward which said astronomical telescope is headed.

10 [4] A terminal device in accordance with any one of claim 1 to 3, characterized in that an operation of said rotation command means allows said star map image displayed in said image display section to be scrolled.

[5] A terminal device connectable to an automatic
15 introduction apparatus for automatically introducing a target celestial object by controlling a rotation of an astronomical telescope around at least two axes, said terminal device being characterized in comprising:

an input operation section for executing a command
20 operation on said automatic introduction apparatus;

an image display section for indicating a star map image for a predetermined area on a celestial sphere in accordance with a display scale factor;

an azimuth detection means for detecting an azimuth
25 along the direction to which said terminal device is oriented; and

a gradient detection means for detecting a gradient along the direction to which said terminal device is

oriented, wherein

said image display section includes a constellation quick reference mode for displaying a star map image for a predetermined area which is observed along the direction
5 specified by the azimuth detected by said azimuth detection means and the gradient detected by said gradient detection means at a current date and time and a longitude and latitude of an observation site.

[6] A terminal device in accordance with claim 5, wherein

10 in said constellation quick reference mode, at least one of a celestial object selecting mode and a telescope control mode can be executed,

said celestial object selecting mode allowing either of a target celestial object for automatic
15 introduction or a fundamental celestial object for alignment to be selected over said star map image displayed in said image display section, and

said telescope control mode providing a control of said astronomical telescope so as to be oriented toward
20 a direction specified by the azimuth detected by said azimuth detection means and the gradient detected by said gradient detection means.

[7] An automatic introduction apparatus for automatically introducing a target celestial object by controlling a
25 rotation of an astronomical telescope around at least two axes, said apparatus being characterized in comprising:

an image-capturing means for taking an image of celestial object;

a celestial object database; and

a celestial object identification means for
identifying a celestial object whose image has been
captured by said image-capturing means, by comparing said
5 image of celestial object captured by said image-capturing
means with a set of celestial object information in said
celestial object database, wherein

an alignment process for defining a set of coordinate
transformation information of a coordinate system in said
10 astronomical telescope relative to a celestial coordinate
system is executed based on a set of position information
for said celestial object identified by said celestial
object identification means.

[8] An automatic introduction apparatus in accordance
15 with claim 7, characterized in that

said image-capturing means is adapted to capture an
image at a plurality of focal distances, and

said alignment process includes the steps of:

capturing an image of a celestial object under a
20 condition where said image-capturing means has been set at
a focal distance for a wide angle side;

identifying a celestial object in said celestial
object image captured at said wide angle side;

correcting said coordinate transformation
25 information based on the position information of said
identified celestial object;

selecting a fundamental celestial object from
said celestial object image captured at the wide angle

side;

controlling a rotation of said astronomical telescope so that said fundamental celestial object is introduced into a center of field in the captured image;

5 capturing an image of a celestial object under a condition where said image-capturing means has been shifted to a focal distance for a more telescopic side;

identifying a celestial object in said celestial object image captured at the more telescopic side;

10 correcting said coordinate transformation information based on the set of position information of said identified celestial object; and

setting said image-capturing means sequentially at different focal distances for the more telescopic side
15 and repeating above respective steps until the fundamental celestial object is introduced into a center of field in the captured image with a sufficient precision.

[9] An automatic introduction apparatus in accordance with claim 8, in which said alignment process is executed
20 by using at least two fundamental celestial objects.

[10] An automatic introduction apparatus for automatically introducing a target celestial object by controlling a rotation of an astronomical telescope around at least two axes, said apparatus being characterized in comprising:

25 an image-capturing means for capturing an image of a celestial object;

a celestial object database; and

a celestial object identification means for

identifying a celestial object whose image has been
captured by said image-capturing means, by comparing said
image of celestial object captured by said image-capturing
means with a set of celestial object information in said
5 celestial object database, wherein

said astronomical telescope is configured to be
rotationally controllable so as to introduce said target
celestial object into a center of a field of said
astronomical telescope based on a set of position
10 information for said celestial object identified by said
celestial object identification means.

[11] An automatic introduction apparatus in accordance
with claim 10, characterized in that

said image-capturing means is adapted to capture an
15 image at a plurality of focal distances, and

said automatically introducing process includes the
steps of:

introducing said target celestial object
automatically;

20 capturing an image of a celestial object under a
condition where said image-capturing means has been set to
a predetermined focal distance;

identifying a celestial object from said
celestial object image captured by said image-capturing
25 means;

controlling said astronomical telescope to rotate
so that said target celestial object is introduced into a
center of field in the captured image based on the set of

position information for said identified celestial object;
and

setting said image-capturing means sequentially at
different focal distances for the more telescopic side and
5 repeating the above respective steps until said target
celestial object is introduced into the center of a field
in the captured image with a sufficient precision.

[12] An automatic introduction apparatus in accordance
with claim 10, in which said celestial object
10 identification means has a function to extract an area
including a celestial object that has not been image-
captured based on said celestial object images captured by
said image-capturing means and to determine whether said
target celestial object exists in said area.

15 [13] An automatic introduction apparatus for automatically
introducing a target celestial object by controlling a
rotation of an astronomical telescope around at least two
axes, in which

said automatic introduction apparatus is equipped
20 with a Web server function via an electric communication
means, and thereby allows two-way data communication with a
terminal device equipped with a Web browser function and
one or more additional automatic introduction apparatus(es)
via said electric communication means.

25 [14] An automatic introduction apparatus for automatically
introducing a target celestial object by controlling a
rotation of an astronomical telescope around at least two
axes, in which

said automatic introduction apparatus is equipped with a Web server function via an electric communication means, and thereby allows two-way data communication with a plurality of terminal devices each equipped with a Web browser function via said electric communication means.

[15] An automatic introduction apparatus in accordance with claim 14, in which said electric communication means is further provided with one or more additional automatic introduction apparatus.

[16] An automatic introduction apparatus in accordance with claim 14 or 15, in which each of said plurality of terminal devices includes an input operation terminal for inputting a command to said automatic introduction apparatus and a display terminal for indicating a set of received input and output information.

[17] A control system for an astronomical telescope, comprising:

a plurality of automatic introduction apparatuses, each capable of controlling a rotation of its corresponding astronomical telescope to automatically introduce a target celestial object; and

a single terminal device having a right of control of said plurality of automatic introduction apparatuses,

said plurality of automatic introduction apparatuses and said single terminal device being interconnected via an electric communication means.

[18] A control system for an astronomical telescope in accordance with claim 17, in which

each of said automatic introduction apparatuses has a manipulation means for inputting a command to said automatic introduction apparatus, said manipulation means comprising at least one of:

- 5 an operation starting means for starting a control operation to the astronomical telescope based on a command signal from said terminal device; and

- a priority manipulation means for giving a priority to a command from said manipulation means over a
10 command from said terminal device regarding at least one operation of a corresponding astronomical telescope.

[19] A control system for an astronomical telescope in accordance with claim 17, in which

- each of said plurality of automatic introduction
15 apparatuses has a manipulation terminal for inputting a command to said automatic introduction apparatus, and

 said system allows the right of control of said terminal devices to be transferred to either one of said plurality of manipulation terminals.

- 20 [20] A control system for an astronomical telescope in accordance with claim 17, in which said terminal device is equipped with an individual control mode for exclusively controlling at least one specified automatic introduction apparatus.

- 25 [21] A control system for an astronomical telescope in accordance with claim 17, in which said terminal device comprises a display means for displaying a set of received information from each automatic introduction apparatus.

[22] A control system for an astronomical telescope in accordance with claim 21, in which said received information includes at least one of:

operation ending state for each one of said automatic
5 introduction apparatuses;

information indicating a direction or a position on a celestial sphere to which each astronomical telescope is oriented;

electric mail information from a user of each
10 automatic introduction apparatus; and

image data of a celestial object taken through each astronomical telescope.

[23] A control system for an astronomical telescope in accordance with claim 17, in which

15 said terminal device stores a set of information for alignment to be required for the automatic introduction in each one of said astronomical telescopes and re-establishes said information for alignment in each one of said automatic introduction apparatuses upon subsequent starting
20 of said control system.

[24] A control system for an astronomical telescope, comprising:

a plurality of terminal devices, each transmitting a request signal for an introduction of a celestial object
25 via an electric communication means; and

an automatic introduction apparatus connected to said electric communication means and operable in response to said request signal for the introduction of a celestial

object to control a rotation of a single astronomical telescope for automatically introducing a target celestial object, wherein

5 said automatic introduction apparatus, upon receipt of the request signal for the introduction of celestial object from each of said plurality of terminal devices, assigns an execution sequence to said request signal for the introduction of celestial object in accordance with a predetermined sequence so as to allow respective target
10 celestial objects to be introduced automatically and serially in accordance with said execution sequence.

[25] A control system for an astronomical telescope in accordance with claim 24, in which said predetermined sequence is defined by either one of:

15 (1) a sequence in which said request signal for introduction of celestial object received earlier by said automatic introduction apparatus has a priority over others;

20 (2) in a case where said automatic introduction apparatus is equipped with a terminal device directly connected to said automatic introduction apparatus, a sequence in which the request signal for introduction of celestial object from other terminal device capable of being manipulated by said directly connected terminal
25 device has a priority over others; and

 (3) in a case where a plurality of request signals for introduction of celestial object have different receipt times falling within a predetermined range, a sequence in

which the request signal for introduction of a celestial object specifying target celestial objects located closer to the direction to which said astronomical telescope is currently oriented has a priority over others, and

5 based on the thus defined predetermined sequence, said execution sequence is assigned to said respective request signals for the introduction of a celestial object.

[26] A control system for an astronomical telescope in accordance with claim 24, in which each of said plurality
10 of terminal devices comprises a display means,

 said display means being capable of displaying at least one of:

 operation ending state for each one of said automatic introduction apparatuses;

15 information indicating a direction or a position on a celestial sphere to which said astronomical telescope is oriented;

 information concerning the celestial object to be introduced by said astronomical telescope; and

20 image data of celestial object taken through said astronomical telescope.

[27] A control system for an astronomical telescope in accordance with claim 17 or 24, in which said automatic introduction apparatus comprises at least one of:

25 a stop means for executing an emergency stop of rotational driving of said astronomical telescope in case of interruption of communication with said terminal device; and

an alarm means for giving an alarm sound or an alarm indication upon starting to drive said astronomical telescope.

[28] A control system for an astronomical telescope,
5 comprising:

a controller having a function as a Web server computer; and

a plurality of automatic introduction apparatuses,
each capable of controlling a rotation of its corresponding
10 astronomical telescope for automatically introducing a target celestial object;

said controller and said plurality of automatic introduction apparatuses being interconnected via an electric communication means, wherein

15 each of said plurality of automatic introduction apparatuses transmits a set of observation information concerning said apparatus, and

said controller executes a predetermined service to each of said plurality of automatic introduction
20 apparatuses based on each set of said observation information.

[29] A control system for an astronomical telescope in accordance with claim 28, in which

said observation information includes a set of
25 information of an introduced celestial object, and

said controller has a function for aggregating received sets of information of said introduced celestial objects and ranking said celestial objects with each other

and executes at least one of services selected from a group consisting of:

(1) a service for notifying said ranking information of the introduced celestial objects to said plurality of automatic introduction apparatuses;

(2) a service for selecting at least one celestial object from said ranking information of the introduced celestial objects and instructing said plurality of automatic introduction apparatuses to introduce said celestial object; and

(3) a service for instructing said plurality of automatic introduction apparatuses to introduce those celestial objects selected into a high ranking sequentially in accordance with said ranking information of the introduced celestial objects.

[30] A control system for an astronomical telescope in accordance with claim 28, in which said controller has a function for classifying a type of user of each automatic introduction apparatus based on said received observation information.

[31] A control system for an astronomical telescope in accordance with claim 30, in which

said type of user includes at least one item selected from a group consisting of a type of celestial object of interest, a learning level defined from a beginner to an expert and an observation style.

[32] A control system for an astronomical telescope in accordance with claim 30, in which said controller executes

a control operation or a transmission of the celestial object information in association with the classified type of user on each of said automatic introduction apparatuses as said service.

5 [33] A control system for an astronomical telescope in accordance with claim 32, in which said celestial object information includes at least one item of information selected from a group consisting of new celestial object introduction information, version-up information for said
10 automatic introduction apparatus and menu information for celestial object introduction.

[34] A control system for an astronomical telescope in accordance with claim 28, in which said controller executes an arithmetic operation on behalf of said automatic
15 introduction based on said observation information.

[35] A control system for an astronomical telescope in accordance with claim 28, in which
said automatic introduction apparatuses located at respective sites are connected with meteorological sensors,
20 wherein

said controller receives a set of meteorological information detected by each of said meteorological sensors and provides a set of meteorological information associated with each site as said service.

25 [36] A control system for an astronomical telescope in accordance with claim 28, in which

said controller provides either one form of service selected from a group consisting of a chat, a message board

and a TV conference system as said service, in which a use of said service is restricted such that the access is only allowed between the automatic introduction apparatuses determined to be in the observation of the same celestial object based on said observation information or between the automatic introduction apparatuses of the same type of users.

[37] A control system for an astronomical telescope, comprising

10 a plurality of automatic introduction apparatuses, each capable of controlling a rotation of its corresponding astronomical telescope for automatically introducing a target celestial object and being interconnected to each other via an electric communication means, wherein

15 a sequential and shifting control of said plurality of automatic introduction apparatuses enables a serial tracking observation of a celestial object by a plurality of astronomical telescopes.

[38] A control system for an astronomical telescope in accordance with claim 37, in which

20 said respective astronomical telescopes whose rotations are controlled by said plurality of automatic introduction apparatuses have German-style equatorial mounts, wherein

25 when an equatorial telescope of an astronomical telescope during the observation passes over the meridian, a control of said astronomical telescope is shifted to a control of an automatic introduction apparatus of another

astronomical telescope having its lens barrel inverted previously.

[39] A control system for an astronomical telescope in accordance with claim 37, in which

5 said plurality of automatic introduction apparatuses are disposed in different locations, wherein

 a set of information on a movement of a moving celestial object is transmitted by one of said plurality of automatic introduction apparatuses which is currently
10 controlling an astronomical telescope engaged in an observation of said moving celestial object, and the control is shifted sequentially to another of said plurality of automatic introduction apparatuses at another location expecting next emergence of said moving celestial
15 object based on said movement information.

[40] A control system for an astronomical telescope in accordance with claim 37, in which

 each of said plurality of automatic introduction apparatuses disposed in respective locations comprises an
20 observation area detection means for detecting an area on a celestial sphere available for the celestial observation at its associated location, wherein

 when said astronomical telescope engaged in the observation changes its orientation to another area out of
25 said area available for the celestial observation detected by said observation area detection means, the control is shifted sequentially to another of said plurality of automatic introduction apparatuses which has said out-of-

area as its own area available for the celestial observation.

[41] An automatic introduction apparatus in accordance with claim 7 or 10, in which said celestial object database
5 is renewed based on a set of celestial object information obtained via an electric communication means.

[42] An automatic introduction apparatus in accordance with claim 7, in which
an initial parameter for said alignment process is
10 established automatically based on a set of position information of a celestial object identified by said celestial object identification means.